6 Data

6.1 NCR Files

The NCR file includes only non-calculated quantities (e.g., static pressure, uncorrected temperature, unblended positions and velocities from GPS and accelerometers, etc.). The structure of the NCR files is based on the netCDF file structure (Rew et al. 1997).Further information on these netCDF libraries can be found at www.unidata.ucar.edu/packages/netcdf. Users familiar with the netCDF file type will be able to read these files with tools available for accessing standard netCDF libraries.

The header of the file contains information relating to the data variables, their dimensions, attributes for each variable, and attributes for the entire file. All of the data are stored either as short-word (4-byte) or long-word (8-byte) integers. All variables either contain one or two dimensions. The primary dimension for the NCR variables is *scan* which is equal to the number of seconds contained in the file. Higher rate variables (greater than 1 Hz) have a second dimension. For the present data set, channels were sampled at either 5, 10, 50 Hz, or 150 Hz, depending on the variable. Thus, 5-, 10-, 50- or 150-Hz data have a second dimension of *5HzData*, *10HzData*, *50HzData*, or *150HzData*, respectively.

Table 4 lists all of the variables in the NCR files along with a short description of each. Most of these variables are native N3R data. Three additional variables include information related to good/bad data flags. Native N3R variables have eight attributes. The *scale_factor* and *add_offset* attribute are used to convert the data into floating point numbers in the proper engineering units (as defined by the attribute *units*). The attributes *valid_min* and *valid_max* define the range in which values must fall between for them to be valid. The *fill_value* attribute has value either -1, 0, or 1. For *fill_value* = -1, non-valid data will have values equal to the *valid_min*. For *fill_value* = 1, non-valid data will have values equal to the *valid_max*. For *fill_value* = 0, non-valid data will have values equal to 0. The *long_name* attribute simply furnishes a longer, more detailed name for the variable. Finally, the attribute *cal_coef* is a six- element vector containing 5-degree polynomial coefficients used to convert data from raw voltages into engineering units. This information is already contained within the *scale_factor* and *add_offset*, but is required to change the calibration at a later time, if necessary.

Global attributes (file-wide) include the title and date of the file. The *title* attribute contains the name of the aircraft and the associated experiment or project. The *date* attribute describes the day the file was acquired. All other global attributes are used to describe the names of the processing programs executed on the data. For each program there exists two attributes, one that describes the control version of that program and another describing the date it was executed. For example, each NCR file should have an attribute *filterspike* that is equal to a character string describing the control version of *filterspike* that was run (*i.e.*, filterspike.c, v1.2). Each should also have an attribute *filterspike_date* describing the date and time *filterspike* was executed. This attribute is also stored as a character string. Note that quality flag variables PVflag and Angflag are determined in *bin2nc* while the variable Ambiguities is output from *flykin*.

Table 4. Summary of NCR file variables.

Variable	Units	Freq	S/A	Description
GPSTime	s	1	S	Ashtech Time
TTime	s	10	S	TANS-vector Time
NLat	deg	5	S	Ashtech Latitude
NLon	deg	5	S	Ashtech Longitude
NAlt	m	5	S	Ashtech Altitude
Nu	m s^{-1}	5	S	Ashtech Velocity (east)
Nv	m s^{-1}	5	S	Ashtech Velocity (north)
Nw	m s^{-1}	5	S	Ashtech Velocity (vertical)
TPitch	deg	10	S	TANS-vector Pitch
TRoll	deg	10	S	TANS-vector Roll
THdg	deg	10	S	TANS-vector Heading
Px	mb	50	A	Differential Pressure (x-axis)
Py	mb	50	A	Differential Pressure (y-axis)
Pz	mb	50	A	Differential Pressure (z-axis)
Ps	mb	50	A	Static (reference) Pressure
Ax	m s^{-2}	50	A	BAT Probe Acceleration (x-axis)
Ay	m s^{-2}	50	A	BAT Probe Acceleration (y-axis)
Az	m s^{-2}	50	A	BAT Probe Acceleration (z-axis)
Axb	m s^{-2}	50	A	Backseat Acceleration (x-axis)
Ayb	m s^{-2}	50	A	Backseat Acceleration (y-axis)
Azb	m s^{-2}	50	A	Backseat Acceleration (z-axis)
Arol	s^{-2}	50	A	Differential (Roll) Acceleration (normalized)
Tp1	°C	50	A	Fast-Response Microbead Temperature
Fust_mv	:V	50	A	Fast-Response FUST Probe Thermocouple
TBar	°C	1	A	Slow-Response Thermistor Temperature
H2O	g m^{-3}	50	A	IRGA Absolute Humidity
CO2	mg m^{-3}	50	A	IRGA Carbon Dioxide
Tdew	°C	1	A	Chilled Mirror Dew Point Temperature
SfcT	°C	50	A	Sea Surface Temperature
SkyT	°C	1	A	Sky Temperature
Qs_up	W m^{-2}	1	A	Downwelling (Upward Looking) Visible Radiation
Qs_dn	W m^{-2}	1	A	Upwelling (Downward Looking) Visible Radiation
BodyT	°C	1	A	Everest 4000.4GXL (SST) Body Temperature
L1Dist	m	150	S	Distance (left wing)
L2Dist	m	150	S	Distance (instrument pod)
L3Dist	m	150	S	Distance (right wing)
L4Dist	m	150	S	Distance (15° “glint” laser)
L1Retn	counts	150	S	Number of Valid Returns (left wing)
L2Retn	counts	150	S	Number of Valid Returns (instrument pod)
L3Retn	counts	150	S	Number of Valid Returns (right wing)
L4Retn	counts	150	S	Number of Valid Returns (15° “glint” laser)
Ka_Ctl	mV	50	A	Ka-band Scatterometer Control
Ka_Rcv1	mV	50	A	Ka-band Scatterometer Receive Channel 1
Ka_Rcv2	mV	50	A	Ka-band Scatterometer Receive Channel 2
PVflag		5		Position / Velocity Flag
Angflag		10		Angles Flag
Ambiguities		5		Number of Ambiguities for Differential Correction

6.2 NCP Files

The NCP file contains derived quantities such as the wind velocity, corrected air temperature, and dry air density. Like the NCR file, the structure of the NCP is based on netCDF. All of the variables contained within the NCP file are either 1 Hz (dimension *scan*), 50 Hz (dimensions *scan* and *50HzScan*), or 150 Hz (dimensions *scan* and *150HzScan*). Table 5 lists the variables in the NCP files with a short description of each. Also contained in the table are variable dependencies for derived quantities. For example, NAlt (altitude) in the NCP file depends not only on NAlt in the NCR file, but also on the three BAT probe accelerations (Ax, Ay, and Az) used to augment the 10-Hz GPS data. Note also that NAlt in the NCP file therefore differs from NAlt in the NCR file.

Data in the NCP file are stored as 4-byte or 8-byte integers. Again, the variable attributes *scale_factor* and *add_offset* are used to convert to floating-point values with the proper engineering units given by the attribute *units*. The final variable attribute is *long_name*.

The variable *Dataflag* uses bit settings to flag bad data. The variable attribute *bit_settings* is a vector string describing the bit settings for this variable. A set bit indicates bad data. The first four bits are reserved for flagging bad winds. Bit one indicates the determination of bad data was made in makepod (the values lie outside some predetermined valid minimum or maximum). Bit 2 indicates bad GPS data (most likely due to missing data). Bit 3 indicates bad TANS-vector data (GPS attitude). Bit 4 indicates no differential corrections for the GPS. This is separate from the bit 2 case because it may result from a lack of ground station data or simply too few satellites to provide useful differential corrections. Bit settings are easily checked using the standard C operators AND, OR, AND/OR (or their non-C equivalent).

6.3 MKR Files

The MKR file contains an ASCII listing of specific times and locations during the flight when the pilot toggles the “on/off” switch or presses the “event” button on the control switch box. This file is used to mark the start and end of flux legs, profiles, or other specific maneuvers. When the marker switch is turned “on”, a three-character string of XXX, a value of “-1”, the scan number (i.e., number of elapsed seconds since the start of data acquisition), and current latitude and longitude are written to the MKR file. Similarly, a value of “0” is written with the time and location information when the marker switch is turned off. The event switch is used to mark a specific event during flight (e.g., flying over a buoy, crossing the coastline). An event is recorded in the MKR file with a three-character string of EVT along with the scan number, latitude and longitude. The MKR file is manually edited at the end of the flight. The default character string of XXX is usually replaced with three-character identifiers that are used to describe marker pair. For example, FLX is used to denote flux leg while PRO is used to indicate a profile. Other manually edited notes include a summary of the weather conditions, flight plan, problems encountered, and other remarks that may be helpful during data analysis. Appendix A contains the listings of the marker files from all flights during the CBLAST-Low pilot field study. In addition, a key is provided which identifies each three-character identifier.

Table 5. Summary of NCP file variables.

Variable	Units	Freq	Description	Dependencies
GPSTime	s	1	GPS Time	GPSTime
NLat	deg	50	Latitude	NLat, Ax, Ay, Az
NLon	deg	50	Longitude	NLon, Ax, Ay, Az
NAlt	m	50	Altitude	NAlt, Ax, Ay, Az
GndSpd	m s^{-1}	1	Ground Speed	Nu, Nv
AirSpd	m s^{-1}	1	Air Speed	Px, Py, Pz, Ps, Tp1, TBar, H2O, Tdew
TPitch	deg	50	Pitch	TPitch, Ax, Ay, Az, Ayb, Azb, Arol
TRoll	deg	50	Roll	TRoll, Ax, Ay, Az, Ayb, Azb, Arol
THdg	deg	50	Heading	THdg, Ax, Ay, Az, Ayb, Azb, Arol
Axb	m s^{-2}	50	Acceleration (a-axis)	Axb
Ayb	m s^{-2}	50	Acceleration (y-axis)	Ayb
Azb	m s^{-2}	50	Acceleration (z-axis)	Azb
U	m s^{-1}	50	East Wind Speed	Px, Py, Pz, Ps, Ax, Ay, Az, Ayb, Azb, Arol,
V	m s^{-1}	50	North Wind Speed	Nu, Nv, Nw, TPitch, TRoll, THdg, TBar, H2O,
W	m s^{-1}	50	Vertical Wind Speed	Tdew (all three vectors)
Tp1	°C	50	Air Temperature	Px, Py, Pz, Ps, Tp1, TBar
Fust_mv	:V	50	Air Temperature	to be determined
H2O	g m^{-3}	50	Absolute Humidity	H2O, Tdew
CO2	mg m^{-3}	50	Carbon Dioxide	CO2
Tdew	°C	1	Dew Point	Tdew
Ps	mb	50	Static Pressure	Ps, Px, Py, Pz, Tp1, TBar, H2O, Tdew
RhoD	kg m^{-3}	50	Dry Air Density	Ps, Tp1, TBar, H2O, Tdew
SfcT	K	50	Sea Surface Temperature	SfcT
SkyT	K	1	Sky Temperature	SkyT
Qs_up	W m^{-2}	1	Downwelling Visible Radiation	Qs_up
Qs_dn	W m^{-2}	1	Upwelling Visible Radiation	Qs_dn
L1Dist	m	150	Distance (left wing)	L1Dist
L2Dist	m	150	Distance (pod)	L2Dist
L3Dist	m	150	Distance (right wing)	L3Dist
L4Dist	m	150	Distance (glint laser)	L4Dist
L1Retn	counts	150	No. Valid Returns (left wing)	L1Retn
L2Retn	counts	150	No. Valid Returns (pod)	L2Retn
L3Retn	counts	150	No. Valid Returns (right wing)	L3Retn
L4Retn	counts	150	No. Valid Returns (glint laser)	L4Retn
Ka_Ctl	counts	50	Scatterometer Control	Ka_Ctl
Ka_Rcv1	counts	50	Scatterometer Receive Ch. 1	Ka_Rcv1
Ka_Rcv2	counts	50	Scatterometer Receive Ch. 2	Ka_Rcv2
Dataflag		50	Quality Data Flag	

Note: Dependencies are those variables from NCR files that are used in the calculation of *variable*, for specific bit settings, see variable attribute *bit_settings* in NCP files.

6.4 LOG Files

The LOG file contains a listing of input parameters passed through *makepod*. Contained are switches indicating what instruments were on the aircraft and hence what variables exist in the files. Also included are calibration factors for wind calculations. Filter pass and stop bands are recorded in the LOG files. These describe the frequency bands for the high- and low-pass filters used to blend variables (e.g., TANS-vector GPS data and accelerometers). Valid minima and maxima are also defined. Statistics for the raw and processed variables are determined, including minimum, maximum, and moments.

6.5 Known Problems

There were occasional problems with instrument failures during the CBLAST-Low pilot field study. These problems, generally minor, were quickly identified and corrected. The following is a brief synopsis of those problems.

The roll accelerometer in right wing was not functioning properly for the first three flights. This sensor was probably damaged during a microburst event when N3R was parked at small regional airport in Illinois during its transit from Idaho Falls to Martha's Vineyard. The sensor was replaced prior to Flight 4 and functioned properly for the remainder of the experiment. Data from the roll accelerometers is used to augment the 10-Hz TANS-vector GPS roll data to a rate of 50 Hz. The roll accelerometer data is one of many variables used in the calculation of the wind. Its contribution is useful, but not vital.

Data from the 15° glint laser was invalid during the first two flights because of partial blockage of the optical lens due to a fiberglass cover. As a result, the laser reports a "missing" distance with no return pulses. The hole in this cover was enlarged prior to Flight 3. The glint laser worked properly for this flight, however, a few drop outs remained. The opening in the fiberglass cover was enlarged a second time prior to Flight 4. All glint laser data for the remainder of the field study were valid.

Dew point temperature data acquired by the chilled mirror sensor is questionable during Flight 2. Misalignment of the port-hole openings which lead into the mirror chamber are suspected to cause an over aspiration of the sensor which leads to extreme values reported by the instrument. The port-hole alignment problem was corrected prior to Flight 3. Near the end of Flight 4, the dew point temperature data are questionable. In this case where the MABL was very humid and was marked with patches of visible fog, the sensor may have experienced difficulties in "burning off" moisture residing on the mirror (over saturation).

The TANS-vector GPS usually converges on a proper solution of aircraft pitch, roll, and heading within the first several minutes of operation when the unit is turned on. On occasion, this instrument fails to provide a valid solution. This was encountered during Flight 8 where the TANS-vector GPS did not output valid aircraft attitude data. The flight was prematurely terminated and the TANS-vector GPS was manually reinitialized. Approximately 15 min of TANS-vector GPS data were lost during in the middle of Flight 15. The lack of available satellites may be a possible reason why this instrument failed to provide valid solutions for a short time.

There are several instances where DGPS corrections were not made. The first twenty three minutes of data acquired in Flight 9 could not be differentially corrected because of a brief power outage which shut down the ground station computer. DGPS corrections failed about 15 minutes before the end of Flight 18. DGPS corrections were not available for the first twenty one minutes of Flight 19 because the GPS ground station was started late.

Data from both Everest IR radiometers and the chilled mirror sensor were subject to interference from N3R radio transmissions. As a result, data from these sensors (SfcT, SkyT, Tdew) have occasional spikes which may last up to several seconds. Radio transmissions were avoided during flux legs and other specific maneuvers in order to minimize the spikes in these variables. No attempt was made to remove the spikes.